A Summary of Current Program and
Preliminary Report of Progress

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TOBACCO RESEARCH

of the

United States Department of Agriculture
and Cooperating Agencies

This progress report is primarily a research tool for use of Department scientists and administrators in program coordination, development, and evaluation; and for use of advisory committees in program review and development of recommendations for future research programs. The summaries of research progress include some tentative results that have not been tested sufficiently to justify general release. Such findings, when adequately confirmed, will be released promptly through established channels. Because of this, the report is not intended for publication and should not be referred to in literature citations. Copies are distributed only to members of Department staff, advisory committee members, and others having a special interest in the development of public agricultural research programs.

This report also includes a list of publications reporting results of U.S.D.A. and cooperative research issued during the past year. Current agricultural research findings are also published in the monthly U.S.D.A. publications, Agricultural Research, Agricultural Marketing, and The Farm Index.

UNITED STATES DEPARTMENT OF AGRICULTURE
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ADVISORY COMMITTEES

The research program of the Department of Agriculture is reviewed annually by the following advisory committees:

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ORGANIZATIONAL UNIT PROGRESS REPORTS

Source materials used by the Advisory Committees are of two types. First there are organizational unit reports that cover the work of the Divisions or Services listed below. The number prefixes refer to advisory committees listed above that review all of the work of the respective Divisions or Services.

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6 - Forest Service (FS)

Three organizational unit reports are not reviewed in entirety by any one committee. All of the information in them is included in the subject matter reports.

Agricultural Research Service (ARS)

Agricultural Engineering
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Entomology

SUBJECT MATTER PROGRESS REPORTS

The other type of report brings together the U.S.D.A. program and progress for the following commodities and subjects:

1 Cross Commodity Research of Agricultural Engineering, Crops, and Entomology Research Divisions
3 Rural Dwellings
6 Forestry (Other than Forest Service)
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A copy of any of the reports may be requested from James F. Lankford, Executive Secretary, Oilseed, Peanut and Sugar Crops Research Advisory Committee, Agricultural Research Service, U. S. Department of Agriculture, Washington, D. C.

Introduction

This report deals with research on all types of tobacco. However, it does not include extensive cross-commodity work, much of which is basic in character, which contributes to the solution of not only tobacco problems, but also to the problems of other commodities. Progress on cross-commodity work is found in the organizational unit reports of the several divisions.

The report covers Farm Research; Nutrition, Consumer, and Industrial Use Research; and Marketing and Economic Research. As shown in the table of contents, there is a breakdown of the research program by problem areas. For each there is a statement of (1) the Problem, (2) the U.S.D.A. Program, (3) A Summary of Progress during the past year on U.S.D.A. and cooperative work, and (4) a list of Publications resulting from U.S.D.A. and cooperative work.

Research on tobacco crops is supported by (1) Federal funds appropriated to the research agencies of the U. S. Department of Agriculture, (2) Federal and State funds appropriated to the ten State Agricultural Experiment Stations and Puerto Rico, and (3) private funds allotted to research carried on in private laboratories or to support of State Station or U.S.D.A. work.

Research by U.S.D.A.

Farm Research in the Agricultural Research Service comprises investigations on breeding and genetics, culture, variety evaluation, diseases, nematodes, weed control, insects, and crop harvesting, handling operations and equipment, and curing. It is carried out in the following divisions: Crops, Entomology, and Agricultural Engineering. The work involves 42.4 professional man-years of scientific effort.

Nutrition, Consumer and Industrial Use Research in the Agricultural Research Service deals with the chemical and physical properties of tobacco leaf and the chemical composition of smoke. This work is done at the Eastern Utilization Research and Development Division, at Wyndmoor, Pennsylvania. The work involves 7.5 professional man-years of scientific effort

Marketing and Economic Research is done in three services. Tobacco research in Agricultural Marketing Service deals with the physical and biological aspects of assembly, packaging, transporting, storing, and distribution from the time the product leaves the farm until it reaches the ultimate consumer. The work involves 3.9 professional man-years of scientific effort. Economic research conducted in the Economic Research Service deals with marketing costs, margins and efficiency; economics of product quality; supply and demand; and outlook and situation. Research in cooperative marketing is conducted by the Farmer Cooperative Service.

The work reported herein is done by the following divisions: Marketing Economics, Economics and Statistical Analysis, and Marketing. The tobacco research in these services involves 4.5 professional man-years of scientific effort.

Interrelationships Among Department, State and Private Research

A large part of the Department's research is cooperative with the State Experiment Stations. Many Department employees are located at State Stations and use laboratory and office space close to or furnished by the Stations. Cooperative work is jointly planned, frequently with the representatives of the producers or industry participating. The nature of cooperation varies with each study. It is developed so as to fully utilize the personnel and other resources of the cooperators, which frequently includes resources contributed by interested producers or industry.

Including both cooperative and State Station projects, tobacco research is carried on by ten of the fifty-three State Agricultural Experiment Stations and in Puerto Rico. The types of work to which the largest amount of effort is devoted include breeding and genetics, diseases, variety evaluation, plant culture, and weed control. There is a regular exchange of information between Station and Department scientists to assure that the programs complement each other, and to eliminate all unnecessary duplication.

Research by industry is sponsored primarily by the cigarette and cigar manufacturers, chemical companies, and machinery manufacturers. All of the tobacco companies conduct vigorous and diverse programs designed to improve the quality of the product and reduce manufacturing costs. These companies are also studying new methods for producing "homogenized tobacco leaf" or "sheet tobacco" for cigarettes or cigar binders or wrappers; development of new tobacco varieties and related organic problems, and chemical composition of leaf and smoke. The tobacco companies work depends considerably upon discoveries resulting from fundamental work by public agencies.

Research by chemical companies is concerned with the development of new tobacco flavoring agents, cigarette paper and filters, chemical for agronomic use, "sheet tobacco" process, and new and improved machinery for manufacturing tobacco products. The Department and other public agencies continue to provide much of the basic data needed to carry out these programs.

The manufacturers of chemicals for disease control and plant growth regulation continue to expand their efforts to produce new products and introduce them into use. The Federal Government assists in this area in the evaluation of new plant growth regulators and their effect on quality.

Basic research done by the Department and States will be utilized by industry and other organizations in their research programs, especially in the further development of improved products and equipment. Industry's cooperation in supporting tobacco research at Federal and State Stations has contributed greatly to its success.

I. FARM RESEARCH

TOBACCO CULTURE, BREEDING, DISEASES, AND VARIETY EVALUATION

Crops Research Div., ARS

Problem. The growing of quality tobacco is faced with high production costs as well as numerous and serious production hazards. The producer is confronted with complex cultural, disease, and handling problems that have a direct influence on the quality and use value of the crop he produces. New varieties of all the several tobacco types are needed that are more resistant to the prevailing diseases, produce leaf that will meet requirements of both domestic and foreign buyers, and provide profitable yields. New methods of processing tobacco, such as the filter cigarettes and homogenized or reconstituted leaf, have resulted in changes in use value or quality. Changes in cultural practices, such as use of maleic hydrazide for sucker control to eliminate manual suckering, have raised additional problems. The annual losses from improper cultural practices and diseases indicate the need of accelerated research.

PROGRAM

Basic and applied research on production problems of flue-cured, burley, Maryland, dark air-cured, dark fire-cured, and cigar types, has been in progress for many years. All types of tobacco have very different specific quality (use value) requirements which can be met by growing in suitable climates on adapted soils, employing proper production practices, and using adapted varieties. The purpose of this work is to aid the grower in economical tobacco culture by reducing as far as possible the hazards inherent in present methods and conditions by development of new or improved practices and varieties to consistently produce at a minimum cost high quality leaf as measured by its use value. Research in tobacco production, breeding, disease, and quality investigations is conducted in the various producing areas to obtain current information which will be of value to growers.

Tobacco research is conducted with close cooperation of the Agricultural Experiment Stations in the following States: Kentucky, North Carolina, South Carolina, Georgia, Tennessee, Wisconsin, Maryland, Florida, West Virginia, Virginia, Connecticut, and Pennsylvania. Cooperation with industry is as follows: Brown & Williamson Tobacco Corporation; Liggett & Myers Tobacco Company; Philip Morris, Inc.; P. Lorillard Company; R. J. Reynolds Tobacco Company; The American Tobacco Company; The Imperial Tobacco Company of Great Britain and Ireland; Bayuk Cigars, Inc.; General Cigar Company, Inc.; Consolidated Cigar Corporation; Cullman

Bros., Inc.; American Sumatra Tobacco Corporation; and Cigar Manufacturers Association of America, Inc.

The Federal scientific effort devoted to research in this area totals 31.7 professional man-years. Of this number 10.7 is devoted to breeding and genetics; 3.7 to diseases; 2.5 to variety evaluation; 13.8 to culture-physiology; and 1.0 to program leadership.

No lines of work were terminated during the reporting period.

PROGRESS

A. Breeding

A new black shank resistant breeding line, P.D. 468, has been developed. P.D. 468 is the first breeding line released carrying resistance from Nicotiana plumbaginifolia. The transfer of a high level of black shank resistance from N. plumbaginifolia to flue-cured N. tabacum was accomplished in our cooperative programs in South Carolina by breeding studies which were initiated in 1951. The pedigree of P.D. 468 involves an initial cross with a tetraploid from the flue-cured variety 402 and N. plumbaginifolia followed by two backcrosses to the variety Golden Wilt. In most characteristics P.D. 468 compares favorably with the flue-cured varieties; however, yields were somewhat lower. The development and availability of a breeding line with resistance from N. plumbaginifolia is a major accomplishment and provides all breeders with an additional source of resistance to combine with others already available. Better varieties for growers should result from this accomplishment.

Promising advanced breeding lines were identified within breeding plots in North Carolina during 1962. All of these lines possess resistance to the important black shank fungus and to root knot nematodes. Among the most promising lines were 2512, 2514, and 2519. Each of these lines yielded approximately 500 pounds per acre more than the standard Hicks check. In addition they possess acceptable alkaloid levels and have outstanding plant type. Also, lines 1626-5, 2543, and 2570 yielded above present high-yielding standard varieties and had acceptable chemical composition and handling characteristics. All these lines appear stable for type. Lines 1626-5,2512, 2514, 2519, 2543, and 2570 have been entered in the North Carolina Official Variety Tests for 1963. In addition, 2512 and 2514 are entered in the 1963 Regional Variety Tests. Each of these lines is considered an outstanding candidate for varietal material. Among tobacco growers' most pressing needs is a high-yielding tobacco variety with acceptable quality and disease resistance.

Hybrid flue-cured and burley tobaccos are of considerable interest at this time. Tests at Florence, South Carolina, have shown slight evidence of hybrid vigor where 6 black shank resistant flue-cured varieties were crossed in all possible combinations. Considering the data as a whole from the 1962 performance study, the hybrids yielded 144 pounds more per acre and brought $85 more per acre than obtained by averaging the results of different parental combinations. Only in a few combinations did the hybrid perform better than the best parent in the cross. The two varieties that gave the best combining ability, however, were poorest based upon results of smoking tests. The quality of most hybrids seemed to be about the same as the varieties. Tobacco hybrids of some of the available F_1 burley were tested at Waynesville, North Carolina, in comparison with some of the standard burley varieties--Burley 1, 21, Kentucky 9, 10, and 12. None of the hybrids tested were outstandingly better or worse with respect to yield and value than the above-listed standard varieties.

High resistance to tobacco brown spot (Alternaria longipes), as well as resistance to black shank under field conditions in South Carolina, has been demonstrated in a selection from the cigar tobacco variety Quin Diaz (Nicotiana tabacum), designated as Beinhart 1000-1. To study the mode of inheritance of the resistance, crosses were made between Beinhart 1000-1 and susceptible varieties of flue-cured tobacco, Golden Wilt and 402. The data obtained from ratios in the F_1, F_2, F_3, and testcross generations suggest that resistance is governed by a single factor which may be intermediate in its expression. Therefore Beinhart 1000-1 may provide a source of useful resistance to brown spot which should be relatively easy to transfer to flue-cured tobacco varieties.

B. Diseases

Selected breeding lines and varieties are resistant to the common root knot species M. incognita but susceptible to the less common species M. javanica. Florida and Georgia nursery breeding plots infested with the latter species were examined to identify and assay the relative galling by M. javanica. Examinations revealed that some lines were tolerant to this species as judged by slight galling and vigorous growth of plants, while susceptible varieties were severely galled and were not vigorous. Selections within these breeding lines now appear to offer an opportunity to develop resistance to both species of root knot.

Root knot (Meloidogyne spp.) and root-lesion nematodes (Pratylenchus spp.), the two major nematode diseases of tobacco, frequently coexist in the same soils and both contribute to total root damage. Recent development of root-knot resistant varieties now offers an opportunity to eliminate root knot as one of the factors involved in this

complex. Three root-knot resistant varieties were therefore selected for use in assaying more precisely the injury caused by Pratylenchus. A field plot experiment was conducted to compare nematode development (both root knot and lesion) in fumigated plots as compared with non-fumigated. Nematode populations were determined by indicator plants grown in the greenhouse on field soil samples collected at regular three-week intervals during the summer. Results at Florence, South Carolina, in 1962, showed that the comparative response to fumigation among the varieties resistant to root knot and the susceptible Hicks could be used as means to evaluate levels of resistance to Pratylenchus. For example, the difference in amounts of root injury between fumigated and non-fumigated in Hicks was greater than in resistant variety NC 95. Other field tests and nematode population counts confirmed the relative resistance to Pratylenchus in this and in other varieties.

A new carbamate fungicide, zinc-manganese (M-45), when tested at Tifton, Georgia, in 1962, gave highly successful control of blue mold in the plant bed. The new material had a wider margin of safety and was less phytotoxic to tobacco than standard maneb. Tobacco plants in the unsprayed control showed 84% defoliation as compared to 1% defoliation in the plants sprayed twice weekly with M-45 at 1 pound per 100 gallons. As much as 2 pounds of M-45 to 100 gallons of water did not injure tobacco plants, while half this rate of manzate or M-22 (maneb) was phytotoxic.

Blue mold has been a constant hazard to production of cigar-wrapper tobacco in the Connecticut Valley where it is sporadic in occurrence. It is customary to apply fungicides to field plantings when the disease makes its appearance. Control by this procedure has been somewhat erratic apparently because the newer varieties were more susceptible than the varieties grown a few years ago. Varieties in current commercial use in Connecticut and Florida were tested at Beltsville in 1962. The Florida varieties Dixie Shade and Rg had the lowest disease index in both seedling and large plant tests and were much less injured by blue mold than the 15 Connecticut varieties. Connecticut 49, a variety grown extensively at one time, was much less susceptible than any of the other more recently grown Connecticut varieties. This information is of value to growers in selection of varieties to plant.

Accelerated progress in breeding for blue mold resistant tobacco varieties has been made possible by studies on resistance to this disease in large potted plants, as well as seedling tests which previously were used exclusively to test resistance when both are grown in the greenhouse at Beltsville. The cooperative program of research to develop resistance to blue mold from N. debneyi and N. goodspeedii is now offering more promise because of these findings. Results with large plants as well as the seedlings

clearly indicate that all tobaccos become more resistant to blue mold as plants mature.

C. Varietal evaluation

Interrelationship of variety and fertilizer rates on the chemical composition of flue-cured tobacco was studied at Tifton, Georgia, in 1962. The application of four rates of fertilizer 4-8-12 was increased from 1,000 to 2,500 pounds per acre in 500-pound increments. The four varieties grown were Hicks, NC 95, McNair 12, and Coker 316. The average of all varieties showed an increase in the percent of total ash, total alkaloid, and total nitrogen; a decrease in alkalinity of ash and percent reducing sugars but no marked effect percentage where the fertilizer was increased. There was not complete agreement between tobacco manufacturers as to preference for tobacco grown at the different fertilizer rates or between varieties. In the over-all smoke tests, out of 24 comparisons one tobacco manufacturer preferred tobacco produced at 2,500-pound rate 3 times; at the 2,000-pound rate 9 times; at the 1,500-pound rate 12 times; and at the 1,000-pound rate 0 times. The comparisons of varieties were made for strength of flavor by the same company. Hicks placed first; McNair 12 second; NC 95 third; and Coker 316 fourth.

Development of disease resistant flue-cured tobacco of improved quality was given emphasis, using a laboratory technique for seedling production indexing F_1 and F_2 generations for total alkaloids by seedling analysis. The 8038 breeding line and its derivatives which had previously been found to produce cured leaf of excellent physical properties, especially color, was used in this study. In addition to sampling seedlings, mature green plants and cured leaf samples were analyzed for alkaloid content. The correlation coefficient for mean alkaloid content of cured leaf with alkaloid content of the seedlings was highly significant, the value being .49.

The development of Hicks-like disease-resistant flue-cured tobacco varieties that produce profitable yields of acceptable nicotine content is being continued. The selections under study from 383-5 (F_7 of C 139 x Bel 4-3 x C 139 x 5346) were 24 in number and from 1629 (F_5 of 8037 x Hicks x NC 75) there were 8 selections. Seedling analysis of some 1629 selections indicated that they were high (above Hicks) in total alkaloid content. Control varieties grown for comparison in this test were NC 95, Hicks and Coker 316. Some selections substantially exceeded NC 95 or Hicks which were much alike in total alkaloid content at the final sampling date, and others were lower than Coker 316.

Because of the present embargo on Cuban leaf, there has been some interest in learning whether any of the available Cuban varieties will produce leaf quality similar to Cuban-grown tobacco when

produced in the United States. Tests have been carried out on Cuban varieties in Pennsylvania, Wisconsin, Massachusetts, and Florida, and crosses have been made at Beltsville with Cuban and domestic cigar tobacco varieties. Several of the cigar manufacturing companies have volunteered to carry out necessary evaluations on leaf produced in these areas.

D. Culture and Physiology

Tests at Tifton, Georgia involving the use of polyethylene film as a material for covering plant beds showed temperature readings 30 to 40° F. on clear days with full sunshine, above that under regular cloth covers. However, on days of heavy overcast the temperature readings were about equal. Higher humidity was observed under plastic covers. Plant beds covered with polyethylene film produced transplantable plants within 63 to 70 days from the date of seeding, while similar beds covered with regular cloth covers required 83 to 111 days. Plant production increased 55% on a plastic-covered area as compared with the cloth-covered area when fertilizer was applied at 1 pound of 4-9-3 fertilizer per square yard. Increasing the fertilizer above 1 pound per square yard resulted in a reduction of plant production under the plastic cover.

Tests to determine if burley plants grown under plastic perform the same following transplanting as those grown under cloth were conducted at Waynesville and Laurel Springs, North Carolina. Plants graded to uniform size were transplanted on the same date in suitably replicated plots. About four weeks after transplanting, some plants from each were cut off about 2 inches above the ground level. When suckers developed, each plant was pruned to one sucker and allowed to grow to maturity in comparison with plants which had not been disturbed, cut off, or pruned. Differences in acre yield, acre value, and value per cwt. were not found in any comparisons of transplants from two types of plant bed covers. Pruning the plants did lower yields and values in comparison with plants not cut off and pruned. These results suggest that the potential productivity of burley tobacco transplants produced under plastic covers is about the same as for plants produced under cloth.

A test comparing plastic film with conventional tobacco cotton for covering plant beds was initiated at Greeneville, Tennessee in 1962. Seed were sown February 20 and March 29. Inclement weather after the early seeding caused a delay of 10 days in applying covers which may have reduced the effectiveness of the plastic. Germination under the tobacco cotton took place 8 days later than under the plastic at the first seeding, and 5 days later after the second seeding. Plant stands were about the same under both types of covers at the early seeding, but tended to be higher under plastic at the later seeding. The early seeding produced more plants under

plastic than under tobacco cotton at the first pulling and transplants were ready two weeks earlier. A greater total number of plants from all pullings was obtained from plastic-covered beds. Both types of covers produced plants at the same time at the later seeding. The plastic-covered beds produced more plants at the first pulling and a greater total from all pullings than tobacco cotton. Plants produced under plastic were satisfactory for transplanting in this particular year but were somewhat spindly as compared with those grown under cloth.

Plant beds require careful attention in regard to ventilation, watering, and anchorage of covers, especially those covered with plastic or glass, as illustrated by results from Landisville, Pennsylvania. The soil should be maintained in a moist but not wet condition and should never be allowed to become dry. This is especially important immediately before and after seed germination. Sufficient ventilation must be given and temperatures under the plastic or glass covers must not be allowed to become too high as the plants are likely to burn.

Transplanting dates have been tested at Waynesville and Laurel Springs, N. C. since 1958. In 1962, the May 20 transplanting gave acre yields, acre values, and value per cwt. of tobacco substantially higher than did the May 30 and June 10 transplantings. There was a sharp drop in value per cwt. as transplanting was delayed. Tobacco plants may be grown to transplanting size under plastic but not under cloth for the early transplanting date.

Environmental growth chamber studies dealing with the effect of daylength and temperature were continued in cooperation with N. C. State College, Raleigh, North Carolina. Plants were grown in constant light but in four different environments with respect to temperature: (1) constant at 30° C.; (2) constant at 15° C.; (3) 9 hours at 30° C.-15 hours at 15° C; (4) 9 hours at 15° C. -15 hours at 30° C. Since light was constant, any measured differences may be attributed solely to temperature. In general, there was a decrease in the total number of leaves formed with a decrease in the number of hours the plants were exposed to warm temperature. Fresh weight, dry weight, and area of the leaves were of the same relationship in the four environments as the number of leaves per plant. Similar results were obtained from earlier experiments when the plants were grown in either 9 or 15 hours of daylength. The dry weight to fresh weight ratio increased with a decrease in length of exposure to warm temperature. The same was true for plants grown on 15 hours of daylength, but not for plants grown on 9 hours of daylength, reported in earlier experiments. Studies with flue-cured, flue-cured Mammoth, and Maryland Mammoth tobaccos in four different environments composed of 9 hours of daylength and day/night temperatures of 30/30, 30/15, 15/30, or 15/15° C. indicate the

same pattern as above for the number of leaves formed per plant per environment. Cold night temperatures, even though the plants were grown on short days, were necessary to produce a low leaf number. Based upon leaf number, these plants may be considered to be stimulated to flower early. The Maryland Mammoth was the extreme producing 73 leaves in 30/30° C. and only 26 in 15/15° C. Furthermore, the Mammoth, even though growing on short days, required warm nights for the expression of the Mammoth characteristics.

Because of quality problems with maleic hydrazide (MH-30) when used for sucker control in tobacco, the Crops Research Division, ARS, has accelerated research to find new chemicals which would control suckers without altering tobacco quality adversely. The research includes evaluations of chemically treated tobacco plants (1) in the greenhouse at Beltsville, Maryland, (2) on field plantings in Puerto Rico during the winter season, and (3) in the tobacco-growing areas of the States during the normal growing season. In two years, more than 5,000 compounds have been tested on plants in the greenhouse. In the first season, three chemicals showed enough promise in Puerto Rico to be included in regional State tests. In the second season in Puerto Rico, 40 new chemicals were tested. Eight of the 40 new chemicals showed enough promise to be further evaluated in the States in the 1963 season. In all tests, the new chemicals are tested under code numbers and are compared with maleic hydrazide and hand suckering. Several treatments are made with each chemical in order to find optimum rates to apply for control of suckers on different types of tobacco. Chemicals are eliminated from further testing if sucker control is inadequate, or there is injury to the growing plant. Compounds of growth-regulating nature, and also those having bud-inhibiting effects, such as various vegetable oils, including tobacco and cottonseed oils, are being investigated.

In a 3-year cropping system test at Greeneville, Tennessee, tobacco was grown following 2-year sods of red clover, orchard grass-ladino clover, Korean lespedeza, and weeds. Tobacco yields following red clover, orchard grass, ladino, and weeds, were all comparatively high and did not differ significantly for the 1962 crop. Yield of tobacco after lespedeza was about 300 pounds less per acre than after the other crops. Tobacco grade quality was highest following weeds, and lowest following lespedeza. In the continuous cropping system, yields and quality were lower than in the 3-year system. Yield after a green manure cover of barley over winter was 900 pounds less than where tobacco followed a winter cover crop of either crimson clover or vetch. Where no cover crop was turned under, the yield of tobacco was about 200 pounds more per acre than after barley.

Prices were higher for the bulk cured leaf of the flue-cured type at Oxford, North Carolina, than for that conventionally cured, based

upon U. S. standard grades. Harvesting two to three leaves at a time over a period of six weeks (conventional) increased the total number of grades and reduced the value of the leaf considerably below that of the less frequent harvestings under conventional curing conditions. When bulk cured, there was little difference. Poorest quality was produced on the early whole and half-plant harvests which simply were not mature. These experiments strongly indicate that varieties can be developed which will produce good quality when taken from the field in two or three harvests. There are also indications that the bulk curing process will accommodate a wider range of ripeness than conventional curing. This is apparently due to better control of humidity under bulk curing conditions.

A curing experiment was conducted at Greeneville, Tennessee for the second year. Two barns of approximately ½-acre capacity were used in the test. One barn was subjected to natural air curing and the other was equipped to use supplemental gas heat when unfavorable conditions prevailed for 12-24 hours, as determined by a hygro-thermograph. Curing conditions were unusually favorable during most of the curing season and supplemental heat was only used a few times for relatively short periods. Weight and quality of the tobacco cured in the two barns was almost identical, demonstrating that supplemental heat is not always necessary.

PUBLICATIONS

Breeding

Burk, L. G. 1962. Haploids in genetically marked progenies of Nicotiana tabacum L. Jour. Heredity, LIII(5), pp. 222-225.

Chaplin, James F. 1962. Transfer of black shank resistance from Nicotiana plumbaginifolia to flue-cured N. tabacum. Tob. Sci. 6, pp. 182-187.

Chaplin, James F. 1963. Undesirable characteristics of mammoth flue-cured tobacco not genetically associated with the mammoth gene. Crop Sci. 3, pp. 158-161.

Chaplin, James F., and Graham, T. W. 1963. Brown spot resistance in Nicotiana tabacum. Tob. Sci. 7, pp. 59-62.

Gwynn, G. R. 1963. Relationships among certain agronomic characters and chemical components in a segregating population of tobacco. Tob. Sci. 7, pp. 7-11.

Heggestad, H. E. 1963. Development of disease resistant tobacco varieties in the United States. III World Tobacco Scientific Congress, Feb. 18-26, Salisbury, Southern Rhodesia, 17 pp.

Litton, Columbus C., and Stokes, G. W. 1962. Burley tobacco hybrids. Kentucky Misc. Leaflet 281, 2 pp.

Moore, E. L., Gwynn, G. R., Powell, N. T., and Jones, G. L. 1962. NC 95 a root knot resistant tobacco variety. Res. & Farming 21 (1-2) N. C. Agr. Exp. Sta., p. 9.

Moore, E. L., Powell, N. T., Jones, G. L., and Gwynn, G. R. 1962. Flue-cured tobacco variety NC 95 resistant to root knot, brown spot, black shank and the wilt diseases. N. C. Agr. Exp. Sta. Bul. No. 419, 18 pp.

Diseases

Apple, J. L., Chaplin, J. F., and Mann, T. J. 1962. Efficacy of Nicotiana glutinosa resistance in controlling mosaic of flue-cured tobacco. Phytopathology 52(8), p. 722.

Apple, J. L., Chaplin, J. F., and Mann, T. J. 1963. Comparison of the Nicotiana glutinosa resistance factor and milk in controlling mosaic of flue-cured tobacco. Tob. Sci. 7, pp. 46-53.

Graham, T. W. 1963. Use of root knot resistant tobaccos to assess injury caused by root lesion nematodes. Presented Feb. 4-6, 1963 at Southern Agr. Workers' meeting, Memphis, Tenn., 1 p.

Moore, E. L., Kelman, A., Powell, N. T., and Bunn, B. H. 1963. Inoculation procedures for detecting resistance of tobacco to Pseudomonas solanacearum in the field. Tob. Sci. 7, pp. 17-20.

Valleau, W. D., Litton, C. C., and Johnson, E. M. 1962. Susceptibility of wildfire resistant tobacco varieties to certain strains of Pseudomonas tabaci and P. angulata. Plant Disease Reporter 46, pp. 36-37.

Variety Evaluation

Chaplin, J. F., Graham, T. W., and Ford, Z. T. 1962. Agronomic and chemical characteristics of certain old-line varieties of flue-cured tobacco. Tob. Sci. 6, pp. 16-20.

Chaplin, J. F. 1962. Fewer tobacco leaves may give best results. Crops and Soils, Nov. issue, p. 20.

Ford, Z. T., Chaplin, J. F., Graham, T. W., and Currin, R. E. 1962. Performance of tobacco varietiesat the Pee Dee Experiment Station in South Carolina 1962. S. C. Exp. Sta. Agron. & Soils. Ser. Bul. 37, 19 pp.

Culture and Physiology

Atkinson, W. O., Link, L. A., and Bortner, C. E. 1962. Effects of potassium fertilizers on yield, value, and chemical composition of burley tobacco. Tob. Sci. 6, pp. 110-113.

Davis, R. L., and Nichols, B. C. 1962. Effects of time of fumigation and sources of nitrogen on burley tobacco plant production. Tenn. Agr. Exp. Sta. Bul. 340, 16 pp.

Engle, H. B., McMurtrey, J. E., Jr., and Brown, D. E. 1962. Mulches for Maryland and Pennsylvania tobacco. Tob. Sci. 6, pp. 82-87.

Garner, W. W. 1962. Effects of light on plants, a literature review, 1950. ARS 34-34, 58 pp.

Jeffrey, R. N., and Cox, E. L. 1962. Effects of maleic hydrazide on the suitability of tobacco for cigarette manufacture. ARS 34-35, 48 pp.

Nichols, B. C., Davis, R. L., Bowman, D. R., and McMurtrey, J. E., Jr. 1962. Further studies in fertilizing burley tobacco in the central basin. Tenn. Agr. Exp. Sta. Bul. 341, 24 pp.

Nichols, B. C., Davis, R. L., and McMurtrey, J. E., Jr. 1962. A comparison of sulfate and muriate of potash for production of burley tobacco seedlings. Tenn. Exp. Sta. Bul. 342. 14 pp.

Seltmann, Heinz. 1963. Studies with flue-cured seedlings during the first three weeks of growth. Tob. Sci. 7, pp. 37-40.

Shaw, Luther and Whitty, E. B. 1963. Plastic covers for burley tobacco plant beds. Tob. Sci. 7, pp. 54-58.

Skoog, Harold A. 1962. Chemical weed control in burley tobacco plant beds. Tenn. Agr. Exp. Sta. Bul. 346. 24 pp.

Tso, T. C., Burk, L. G., Sorokin, T. P., and Engelhaupt, M. E. 1962. Genetic tumors of Nicotiana. I. Chemical composition of N. glauca, N. langsdorffii, and their F_1 hybrid. Pl. Physiol. 37, pp. 257-260.

Tso, T. C., McMurtrey, J. E., Jr., and Jeffrey, R. N. 1962. Mineral deficiency and organic constituents in tobacco plants. III. Plant growth and alkaloid contents related to gradual development of calcium or boron deficiency symptoms. Pl. Physiol. 37, pp. 804-808.

Tso, T. C. 1962. Some novel concepts on the biosynthesis and biogenesis of tobacco alkaloids. Bot. Bul. of Acad. Sinica, 3, pp. 61-71.

Tso, T. C., and Jeffrey, R. N. 1962. Biochemical studies on tobacco alkaloids. V. The incorporation of H^3 in alkaloid biosynthesis. Arch. Biochem. & Biophys. 97, pp. 4-8.

Tso, T. C., and Engelhaupt, M. E. 1963. Amino acid content related to gradual development of calcium and boron deficiency symptoms in tobacco plants. Tob. Sci. 7, pp. 12-16.

Tso, T. C., and Sorokin, T. 1963. Sugar and organic acid contents related to gradual development of calcium and boron deficiency symptoms in tobacco plants. Tob. Sci. 7, pp. 7-11.

TOBACCO INSECTS

Entomology Research Div., ARS

Problem. Profitable production of tobacco depends on the control of insects, particularly budworms, hornworms, flea beetles and aphids. Insecticides that have proved effective for the control of these insects have resulted in undesirable residues on cured tobacco. Such residues adhere to the leaf through commercial processing into cigarettes and some have been found in the main-stream of smoke from commercial cigarettes. There is, therefore, need for the development of effective methods of controlling insect pests of tobacco that will not lead to insecticide residues in cigarettes or other manufactured tobacco products. This would include more intensive research on lures, traps, sterilization, and other new approaches to control; better utilization of predators, parasites, and diseases of tobacco insects; evaluation of tobacco varieties which resist insect attack; and continued research for chemicals that leave no residue.

USDA PROGRAM

The Department has a continuing program involving basic and applied research on tobacco insects to develop effective control methods that will not lead to insecticide residues in cigarettes or other manufactured tobacco products. The program is cooperative with State and Federal entomologists, chemists, agronomists, and agricultural engineers in the States where research is underway, and with the tobacco industry. Studies are conducted at Oxford, N. C.; Florence, S. C.; and Quincy, Fla.

The Federal scientific effort devoted to research in this area totals 5.7 professional man-years. Of this number, 1.1 is devoted to basic biology, physiology and nutrition; 0.6 to insecticidal and cultural control; 0.1 to insecticide residue determinations; 0.8 to biological control; 2.3 to insect sterility, attractants, and other new approaches to control; 0.3 to evaluation of equipment for insect detection and control; and 0.7 to program leadership.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

A. Basic Biology, Physiology and Nutrition

1. Hornworms and Budworms. Studies of the effect of the sucker control chemical MH 30 on overwintering populations of hornworms and budworms have shown that hornworm numbers on suckers after harvest are very greatly reduced in treated fields. Budworms may be reduced if the late suckers are small. On the other hand, the population of diapausing budworms may be increased in some cases if flowering is delayed beyond September 15.

Methods of mass rearing hornworms on field grown tobacco have been improved. A fully grown hornworm larva weighs about 10 grams. It has been estimated that a thousand larvae fed on an artificial diet would require about $400 worth of food. In contrast enough tobacco to feed the same number would cost only about $2.00. Therefore, any practical method of mass rearing hornworms must utilize the natural food. After some preliminary experiments in 1962, about 20,000 hornworms were reared by the following method: Moths were released in a large cage covering a quarter acre of field-grown tobacco. Eggs were laid on the plants and the larvae allowed to reach the fifth and last instar, at which time they were collected by hand and placed on specially designed tables. The top of each table was made of hardware cloth and tobacco was hung on racks above it in such a way that hornworms could feed on the leaves and their feces fall through the wire below. On completion of feeding the larvae dropped to the wire and wandered off the table into a box of sawdust in which they pupated.

In 1963 methods of mass rearing were modified as follows: the moths laid their eggs on a small number of potted plants. Plants were then removed to a heated and lighted room where the larvae hatched and fed on the same plants through the second instar. They were then given additional potted plants as needed until they reached the late fourth or early fifth instar when they were placed on tables similar to those used in 1962 and fed cut tobacco. When ready to pupate each larva was placed in a hole in a wooden block. The 1963 method was all indoors and hence could be more closely controlled with about 75% less labor. A bacterial disease on the rearing tables and in the greenhouse was controlled by spraying the plants with a commercial preparation of streptomycin and terramycin at 200 p.p.m. in water.

Radioactive phosphorus has been used to mark male hornworms in such a way that females mating with them can be identified. Male adults were fed 0.07 microcuries of P^{32} in sugar solution. These males were mated with untreated females. The spermatophores were dissected from the females and placed on X-ray film. The films were developed after two weeks. Spermatophores produced within 12 hours after treating the males did not contain enough radioactive material to expose the film, but those produced at least 24 hours after treatment made a satisfactory picture.

A method of rearing the tobacco budworm on bean seedlings was developed in 1960-61, but laboratory-reared stock failed to lay eggs and died out after five or six generations. Other investigators have had the same difficulty with other Phalinidae. In 1962 the method of handling adults was modified so that instead of collecting eggs from single pairs placed in small cages, many moths were allowed to cross freely in a large cage and lay eggs on young tobacco plants. Seventeen generations have been reared by this method with no indication that the stock is running out.

The chief obstacle to mass rearing budworms on bean seedlings is that the larvae pupate in the tangled mass of roots and soil and are very difficult

to extricate. Some improvement has been made by growing the beans over hardware cloth in such a way that the larvae are forced to pupate above the root mass or in vermiculite placed on the sides.

B. Insecticidal and Cultural Control

1. Wireworms. The importance of wireworms as tobacco pests is illustrated by the fact that more than 70% of the tobacco growers in South Carolina used insecticides for wireworm control in the spring of 1963. The two species of wireworms that are serious pests of newly set tobacco plants have become resistant to most of the chlorinated hydrocarbon insecticides. Therefore, extensive field experiments have been conducted at Florence, S. C., to find more effective insecticides. These experiments have shown that both species can be controlled by either: (1) a preplant broadcast application of 2 pounds per acre of parathion, diazinon, Bayer 25141, or phorate; or (2) by adding from 2 to 3 ounces of a 50% diazinon wettable powder to each 50 gallons of transplant water used with a mechanical transplanter.

2. Hornworms, budworms, and cabbage loopers. On shade-grown tobacco in Florida, Bacillus thuringiensis and endosulfan caused a significant reduction in numbers of hornworms. Endosulfan also reduced the numbers of budworms and cabbage loopers.

C. Insecticide Residue Determinations

1. Endrin. In 1962 endrin residues of 3.15 p.p.m. were found on flue-cured tobacco and 7.8 p.p.m. on cigar wrapper tobacco. Samples of the flue-cured were taken from 50 different piles of tobacco in each warehouse sampled. Three warehouses were sampled in Florida and Georgia, 5 in South Carolina, and 15 in North Carolina. These were analyzed for endrin by the Pesticide Chemicals Research Branch. Endrin was found on the samples from all markets except one. The most endrin on flue-cured tobacco was found in Florida and the eastern belt of North Carolina.

2. Phorate. Phorate applied to the soil for wireworm control had a marked deleterious effect on the quality of the tobacco. In 1962 tobacco was harvested from plots treated with Zinophos, phorate, Kepone bait, and no treatment, and submitted to the American Tobacco Company for tests and flavor evaluation. Zinophos and Kepone had no effect, but phorate applied as 10% granules at the rate of 2 lb. of phorate per acre caused an objectionable taste in cigarettes. Chemical analysis showed that the phorate-treated samples were higher than any of the other treatments in percent total volatile bases and total sugar and lower in nicotine and ash.

D. Insect Sterility, Attractants and Other New Approaches to Control

1. Tobacco Hornworm. At Florence, S. C., field testing of extracts of virgin female hornworm moths proved that they were highly volatile and attractive to males for only one night. Work is underway to stabilize the

sex attractant for use under field conditions and to produce large numbers of female moths for extraction of sex attractant.

A number of years ago several investigators used trap cages that were baited with isoamyl salicylate to capture hornworm moths in the field. While such trap catches did not control the hornworms, a large number of moths could be trapped in this manner. Recently, this type of trap has been baited with a sex attractant to lure male moths. However, most of the moths that got into the trap escaped during the night.

In attempts to sterilize hornworms it has been found that high dosages of gamma radiation are required to kill or cripple the pupae. About 3,000 male pupae taken from overwintering stock but not in diapause at the time of treatment were subjected to doses of gamma radiation varying from 0.5 to 90 kr. Doses up to 50 kr had little or no harmful effect. At 90 kr most of the pupae were killed and less than one percent were normal.

2. Tobacco Budworm. Enough budworms have been reared for preliminary sex attractant experiments. Virgin females were placed in a small tight box with a gypsy moth trap covering an opening at either end. This device when placed in a greenhouse with released males caught males after the females were more than 3 days old. Males of all ages were caught. In another experiment, virgin females were ground with ether in a tissue grinder. The resulting suspension was then filtered and the filtrate evaporated on paper which was placed inside a gypsy moth trap. When exposed in a large cage such traps caught more males than the checks but were not highly attractive.

E. Evaluation of Equipment for Insect Detection and Control

A large area experiment to test the effect of light traps on hornworm populations was set up early in 1962 in cooperation with the Agricultural Engineering Research Division. The test area consisted of two tangent circles each 12 miles in diameter and containing 113 square miles. The eastern circle was equipped with 324 traps or about 3 per square mile. Additional traps were placed at intervals of about a mile for a distance of 6 miles on extended radii from the circumference in four directions. In the western circle four lines of 6 traps each were placed in four directions from the center.

The traps were placed on poles 10 feet high, equipped with a 15-watt black light lamp and arranged so that the hornworms were caught in a cage and could be recovered alive. All traps were placed in open areas near farm buildings in order to obtain electric power, but some were near trees or woods.

During the period July 14 to October 10, 1962, 52 traps were examined daily. When the catch per trap was plotted against the distance outward from the center of the light trap area, there was a significant relation between catch and distance. There was no sharp increase at 6 miles where the

number of traps dropped from 3 to less than one per square mile, but instead there was only a gradual increase in catches out to at least 12 miles or 6 miles beyond the edge of the heavily trapped area. This was true of both species and both sexes. It means that hornworms were moving at least 6 miles through the area and perhaps more. Nevertheless, catches outside the trapped area were definitely higher than inside. The estimated reduction in population between the center of the trapped area and traps 12 miles out was 76% for tobacco hornworm males, 55% for females; and 89% for tomato hornworm males, and 59% for females.

Counts were also made of eggs and first-instar larvae in tobacco fields during this same period. These data show a reduction of about 58% in populations between fields 0 to 3 miles and those 9-12 miles from the center.

Since the number of traps per square mile varied considerably due to the availability of power sources and roads, the trap data show that the total number of hornworms caught increased rapidly up to 3 traps per square mile, but more than 3 traps failed to increase either male or female catches. Some of the females caught were dissected to determine if they had mated. In spite of the fact that the traps caught many more males than females there was little difference in the percent of females mated inside and outside the trapped area. Although females may mate as many as three times, 96% of those captured had mated only once.

This experiment will be continued through 1963.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

Basic Biology, Physiology and Nutrition

Allen, Norman, Kinard, W. S., and Jacobson, Martin. 1962. Procedure used to recover a sex attractant for the male tobacco hornworm. Jour. Econ. Ent. 55: 347-51.

Insecticidal and Cultural Control

Allen, Norman and Creighton, C. S. 1962. "Controlling Green June Beetle Larvae in Tobacco Plant Beds." USDA Leaflet No. 504, April.

Creighton, C. S., Kinard, W. S., and Allen, Norman. 1963. The southern potato wireworm, a new pest of tobacco. Jour. Econ. Ent. 56: 292-4.

Insect Sterility, Attractants and Other New Approaches to Control

Allen, Norman, Kinard, W. S., and Jacobson, Martin. 1962. Procedure used to recover a sex attractant for the male tobacco hornworm. Jour. Econ. Ent. 55: 347-51.

Creighton, C. S., Kinard, W. S., and Allen, Norman. 1963. The southern potato wireworm, a new pest of tobacco. Jour. Econ. Ent. 56: 292-4.

TOBACCO HARVESTING, CURING, AND ELECTROMAGNETIC and ULTRASONIC ENERGY FOR INSECT CONTROL

Agricultural Engineering Research Div., ARS

Problem. The cost of harvesting tobacco with hand labor is a major expense in the cost of production. In addition, supply and adequacy of manpower for these operations are becoming progressively less satisfactory. Complete mechanization of the harvesting process is necessary if the United States farmer is to compete effectively on both the domestic and foreign markets.

There is a need to develop better methods, techniques, and equipment for use on farms in preparing tobacco leaf for market. Increased efficiency is needed in the use of labor and equipment in order to perserve quality and prevent damage from mechanical handling. Basic and precise information is essential to improving curing and sorting practices.

To minimize the use of possible hazardous chemicals and their residues as much as possible, there is a need for widespread investigation of non-chemical pest control methods, such as study of insect response to all possible types of radiation and sound and exploration of weak physical links in the life of particular insects.

USDA PROGRAM

The Department has a continuing long-term program involving agricultural engineers engaged in both basic and applied research on the engineering phases of crop harvesting and handling. Tobacco harvesting research is conducted cooperatively with the Experiment Station at Lexington, Kentucky.

Research on curing and sorting is also being conducted in cooperation with the Experiment Stations at Lexington, Kentucky. Efforts are being made to determine the essential practices involved in curing Burley Tobacco and to develop curing systems that will maintain product quality at reduced cost and labor.

The Department has a continuing long-term program of basic and applied research involving agricultural and electrical engineers and physicists working cooperatively with USDA entomologists and with the Experiment Stations. Electrical and physical methods of tobacco insect control are being studied in North Carolina and Virginia.

The Federal scientific effort devoted to research in these areas totals 5.0 professional man-years. Of this number 2.0 is devoted to tobacco harvesting and handling operations and equipment; 2.0 to curing and sorting; .8 electric and physical insect control; and .2 to radiofrequency energy treatment of tobacco seeds.

REPORT OF PROGRESS FOR
USDA AND COOPERATIVE PROGRAMS

A. TOBACCO HARVESTING EQUIPMENT

1. Development of a Mechanical Tobacco Harvester. The function of an experimental harvester is to stalk cut unprimed tobacco, automatically pierce the stalks and place them at regular intervals on conventional wooden sticks. This is a project initiated by the Agricultural Experiment Station, University of Kentucky in 1960, in which ARS personnel are now cooperating. Satisfactory operation of the machine in 1962 was limited to a capacity of three sticks per minute when harvesting primed plants. A new type of spearing mechanism has been designed and successfully laboratory tested. The function of the new spear, termed a "spiral held floating spear" is to permit design capacity of six sticks per minute when operating in unprimed fields. It is proposed to use this spear in future research.

Physical properties of mature burley tobacco plants are needed by design engineers in order to establish design criteria for machines to handle the crop. The objective of current investigations is to define and qualify these properties in engineering terms which will be useful in machine design.

Stalk Strength Properties. Material from the woody portion of tobacco stalks was tested in flexure to determine its modulus of elasticity and proportional limit. Determinations were made for three varieties; Kentucky 10, Kentucky 21, and High Leaf. Small test specimens were sawed from the woody portion of the stalks and sanded to size, approximately 1/4 x 1/4 x 3 1/2-inch test span. Precise measurements of the dimensions were made at time of testing. Moisture content was maintained near field conditions until tests were made and moisture content and density were determined for each test specimen.

Values for modulus of elasticity for the three varieties were determined as follows: Kentucky 10, 386,000 p.s.i.; Kentucky 21, 309,000 p.s.i.; and High Leaf 402,000 p.s.i. Values determined for proportional limit were: Kentucky 10, 2,149 p.s.i.; Kentucky 21, 1,537 p.s.i.; and High Leaf 2,122 p.s.i.

Leaf Responses. The resistance of leaf lamina to external forces was investigated. Leaves from three stalk positions were used and tests were made at different stages of wilting from freshly harvested leaves up to five days of wilting. Both static and dynamic forces were used, with ten levels of loading. Forces were applied to test areas of one square inch in area. After forces were applied the leaves were hung in a curing shed and air-cured. When the leaves were cured they were evaluated for injury due to bruising, based on perceptible difference in color of the test areas. Minimum force to cause discoloration was recorded.

It was found that fresh or turgid leaves were more resistant to bruising than were wilted leaves. Generally speaking, resistance decreased with wilting time; however, it was found to fluctuate considerably in a systematic manner, during the five day wilting period. The static force to cause bruising varied from a maximum of 155 p.s.i. for freshly harvested leaves to a minimum of 30 p.s.i. for leaves wilted four days. The energy to cause bruising by dynamic loading varied from a maximum of 0.46 in.lbs/in^2 for freshly harvested leaves to a mimimum of 0.15 in.lbs/in^2 for leaves wilted three days.

A study was conducted to determine the force required when applied perpendicular to the midrib, to break a leaf from the stalk and the angle the leaf would deflect before rupture occurred. The forces were applied in three directions, up, down, and around the stalk; and at three distances from the point of attachment to the stalk, two, four, and six inches. Leaves were selected from the portion of the stalk from 12 to 18 inches above the ground.

It was found that all leaves could be bent upward until they touched the stalk without rupturing. The angle which the leaves could be deflected downward without rupture compared closely with the angle which they could be deflected around the stalk. Also, the forces required to cause rupture compared closely for the two directions, downward and around the stalk. These angles varied from a mean of 47° for the two-inch distance to a mean of 84° for the six-inch distance. The force required to rupture the midrib varied from a mean of 500 grams for the six-inch distance to a mean of 1,093 grams for the two-inch distance.

Handling of Stalk-Cut Air-Cured Tobacco on Vertically Suspended Strings. The objective of a proposed system of harvesting, handling, and curing stalk-cut tobacco on vertically suspended strings is to reduce labor requirements during harvesting and curing. The system consists of a harvester whose function is to mechanically cut the stalk, automatically fasten the base of each stalk to a continuous string at pre-set intervals, and to convey the "chain" of stalks to a wagon pulled alongside the harvester. The proposed system will utilize an aircure barn having a horizontal rail system near the roof. A movable drum hoist is to be used to pull the tobacco from the wagon to the rails.

The system uses a geometrical configuration of stalks during curing unlike any currently being used. In the fall of 1962 a preliminary test was conducted to determine the feasibility of air-curing when the stalks are placed in an air-cure barn in this manner. Tobacco was placed in a conventional barn having all but the top rail systems removed. The tobacco was suspended from the system at lateral and longitudinal intervals of two feet. Two treatments of stalk interval on the string were tested, 16 inches and 20 inches. The quality of cured tobacco from both string treatments as determined by official government grading did not appear to be different from that cured conventionally.

Handling of Stalk-Cut Air-Cured Tobacco on Pallet-Rack Curing Frames. The objective of a system of handling and curing stalk-cut tobacco on pallet-rack curing frames is to reduce labor requirements during housing. Tests were conducted at the farm of a cooperator. Stalk-cut tobacco was manually placed on pallet-racks in the field at twice the normal curing density. The filled pallet-racks were then hauled on wagons to a clear-span curing barn, the pallet-racks placed in the barn with a fork-lift tractor, and the empty wagons reloaded with empty pallet-racks for return to the field. The system tested required four men in the field, three tractor operators, and a fork-lift operator. During housing, 26.3 man-hours were required to house one acre of tobacco, a reduction of approximately thirty-four percent from that normally required by conventional methods. Quality of the cured tobacco as determined by official government grading was approximately equal to that cured conventionally.

B. TOBACCO CURING

1. Measurement of Leaf Coloring Rates with Time-Lapse Photography. Basic information concerning the tobacco leaf response to the curing environment is needed before steps can be taken to develop curing systems which are compatible with mechanized handling of Burley tobacco. One fundamental response which has been measured is the coloring rate of the leaf in a controlled environment. Preliminary results have indicated that the coloring rate of primed Burley tobacco can be measured by one-frame exposure of 16 mm. movie color film at two-minute intervals over a five-day period. The developed film was used to show the coloring rate visually as a movie at 16 or 24 frames per second. Also, the transmittance of the 16 mm. color film image of the leaf was used as a relative measure of the leaf coloring rates. These measurements indicated that the yellow-to-brown color transition occurred after about 40 hours in an environment of 105° F. and 80 percent relative humidity.

Certain Thermal Properties of Tobacco During the Cure. The objective of this investigation is to determine certain thermal properties of tobacco during the cure--namely, thermal conductivity, specific heat, and thermal diffusivity. These basic properties are necessary in the analysis, design, and development of facilities for controlling the environment and curing process of tobacco. The apparatus used in this investigation was a guarded hot plate designed and constructed after ASTM standard specifications but with a few modifications to account for the biological characteristics of the test specimens. Each test specimen was formed from approximately 25 to 75 individual discs four and one-half inches in diameter cut from the leaf lamina. They were stacked to a thickness of approximately one-half to five-eighths inch when compressed under five p.s.i. pressure.

Although a thorough tabulation of the data has not been completed, initial computations show the thermal conductivity to be in the range of 0.57 to 1.08 B.t.u./(hr.) (ft.^{2}) (^{o}F.)/in. for freshly harvested to cured tobacco (Kentucky 10). The moisture content (wet basis) and bulk density of the specimens were 27.0, 33.7, and 54.5 percent, 45.5 lbs./ft.^{3}, respectively.

C. Electric Traps for Tobacco Insects

Laboratory investigations continued in cooperation with the Virginia Agricultural Experiment Station, Blacksburg, Virginia, on spectral response of hornworm moths exposed to different wavelength bands of ultraviolet and visible radiation. Greater responses were obtained to bands in the ultraviolet region. Again, the best response was at a wavelength of 3654 A. Better responses were obtained at 75^o F. than at 65^o F. and at 80 percent relative humidity than at 70 percent. Similar work will be continued in an effort to obtain a more effective attractant.

A field investigation to determine the effectiveness of blacklight insect traps for population control of tobacco hornworms was conducted near Oxford, North Carolina, in cooperation with the Entomology Research Division, ARS. Results with 324 traps distributed over a 113-square-mile circular area showed that a significantly greater number of moths were caught per trap near the periphery than were caught near the center of the area. An indicated control in excess of 55 percent was determined. Data on hornworm eggs found on tobacco plants also showed that the traps were providing about 50 percent control. This investigation will be continued through the 1963 tobacco-growing season. A similar test is needed on a small island or isolated area to substantiate the results and possibly determine the effectiveness of this technique in combination with other population control measures.

D. Radiofrequency Energy for Tobacco Studies. In cooperation with the Crops Research Division, ARS, several lots of tobacco seed were exposed to severe RF electrical treatments to study possible genetic effects. Some treated samples, which suffered greatly reduced germination, exhibited much higher mutation frequencies than untreated samples. Included were twin-shoot, diminutive, variegated, mottled, and male-sterile aberrant forms. Results indicate that radiofrequency energy may provide a new means for altering germ plasm in plants.

In other cooperative studies with Crops Research Division, RF exposures of tobacco alkaloid preparations for times up to 24 minutes were effective in breaking down the ring structure of the alkaloids where heat treatments alone and shorter RF treatments had failed to do so. Further work is planned to investigate the usefulness of RF energy for modifying tobacco alkaloids.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

None.

II. NUTRITION, CONSUMER AND INDUSTRIAL USE RESEARCH

TOBACCO - COMPOSITION AND PROCESSING

Eastern Utilization Research and Development Div., ARS

Problem. Although neither food nor fiber, tobacco nevertheless is grown on about a million acres, and in seven states provided more farm cash receipts than any other field crop in 1960. The farm value is about $1.3 billion. This crop is unique in that it yields about $3.1 billion in Federal and State taxes. Several serious difficulties plague the industry, among them the lack of genuine scientific knowledge of the composition of tobacco and tobacco smoke which can be used to solve many industrial problems. By knowing the chemical factors in the leaf which result in an acceptable smoke, it would become possible to predict accurately the usefulness of a particular tobacco for smoking purposes, and thus solve a long-standing industrial problem. Methods could also be devised to expedite current time-consuming and erratic methods of fermenting cigar tobacco. Finally, more selective studies on tobacco smoke could be made, including the origin and fate of leaf constituents during burning, the formation of substances having physiological effects, and ways of producing smoke of diverse composition.

USDA PROGRAM

The Department has a continuing program involving chemists and biochemists engaged in basic and applied studies of the chemical composition of tobacco leaf and smoke, directed to better understanding of and improvement in tobacco quality, and to improvement in tobacco processing technology.

The Federal work is conducted at Wyndmoor, Pa., and totals 7.5 professional man-years, 2.0 of which are devoted to study of the composition of tobacco leaf, mainly cigarette tobacco types, and 5.5 to chemical composition of smoke, primarily cigarette smoke. In addition, the Cigar Manufacturer's Association of America supports parallel effort at Wyndmoor equivalent to two professional man-years; this is a study of cigar smoke.

In addition, the Department sponsors research under a P.L. 480 grant to the University of Sao Paulo, Brazil. This is a study of the changes which occur in the composition of tobacco leaves during curing and fermentation.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

A. Composition of Tobacco Leaf

The isolation of unique constituents in either Turkish or flue-cured tobacco would provide a chemical basis for identification of the source of tobacco, but results to date are negative. Neutral constituents of the hexane extract of Turkish tobacco and of comparable fractions of flue-cured tobacco appeared quite similar in respect to column chromatographic behavior and spectrophotometric characteristics of isolated fractions. Neophytadiene levels did not correlate with commercial leaf evaluations of various flue-cured tobaccos

and thus will not provide a chemical basis for predicting leaf usefulness for smoking purposes.

B. Chemical Composition of Smoke

1. Cigarette smoke. Construction of a multiple-capacity smoking apparatus was completed. Gas chromatograms indicate that the steam-volatile neutral components, about 66 different compounds, in smoke from blended and unblended cigarette tobacco, containing flue-cured, burley, Maryland and Turkish tobaccos, differed on a quantitative rather than a qualitative basis. Preliminary results show some correlation between the aroma of flue-cured leaves and the levels of volatile neutral constituents therein but inconsistencies are observed.

2. Cigar smoke. The study on the weakly acidic substances in cigar smoke was completed. The major components of this category are phenol, o-cresol, m-cresol, and/or p-cresol, palmitic acid and 3-pyridinol. The last is a new component not previously found in tobacco or its smoke. Other compounds isolated and identified are 3,4-xylenol, 2,5-xylenol, 3,4-xylenol and 3,5-xylenol(or m- or p-ethylphenol.) On the basis of equivalent weights of tobacco smoked, the phenol content of cigar smoke is appreciably lower than that of unfiltered cigarette smoke.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

Composition of Tobacco Leaf

Bilinsky, W. R., and Stedman, R. L. 1962. Composition studies on tobacco. XIII. Neophytadiene levels in various types and grades. Tobacco Science, 6, pp. 160-161.

Stedman, R. L., Bilinsky, W. R., and Swain, A. P. 1962. Total hexane and ethanol extractives of tobacco. U. S. Dept. Agr., Agr. Research Service Circ., ARS-73-38, 12 pp.

Chemical Composition of Smoke

Ogg, C. L., Bates, W. W., Cogbill, E. C., Blackmore, R. H., and Petersen, E. L. 1962. Determination of total particulate matter, nicotine, and water in cigarette smoke. J. Assoc. Offic. Agr. Chemists, 45, p. 540.

Schmeltz, I., and Schlotzhauer, W. S. 1962. Nonvolatile acids in cigar smoke. Tobacco Science, 6, pp. 88-89.

Schmeltz, I., and Stedman, R. L. 1962. Pyridin-3-ol in cigar smoke. Chemistry and Industry, 27, pp. 1244-1245.

General

Ogg, C. L. 1963. Report on microchemical methods. J. Assoc. Offic. Agr. Chemists, 46, p. 24.

Ogg, C. L. 1963. Report on tobacco. J. Assoc. Offic. Agr. Chemists, 46, pp. 10-11.

III. MARKETING AND ECONOMIC RESEARCH

TOBACCO - MARKET QUALITY

Market Quality Div., AMS

Problem.

Stored tobacco and tobacco products are subject to insect damage that seriously affects the grade, value, and potential end use. The price support program has resulted in a large buildup of stocks, some held for as long as 7 years, about twice the normal period for storage and aging. The long-term storage and the compact, dense structure of the tobacco as stored in hogsheads make insect control difficult. Repeated, heavy applications of fumigants or other control measures during extended storage has raised a question as to the extent and significance of residues that may be accumulated. Treatments applied during storage should be assessed further to be sure they are safe. Measures now used only hold insect populations in check and do little to reduce them or prevent them from becoming established. Attention should be given to the development of measures that will minimize or eliminate the use of chemicals, and at the same time effectively eliminate or prevent infestations. To accomplish this it will be necessary to develop much more basic information than is now available on the ecology, physiology, and behavior of the insects that attack stored tobacco.

USDA PROGRAM

The Department has a long-term program at Richmond, Virginia, involving entomologists engaged in basic and applied research on the insect problems of stored tobacco and tobacco products in the marketing channels. The research is conducted in cooperation with farmers cooperative associations, industry groups, and the Agricultural Stabilization and Conservation Service of this Department.

A continuing program of basic and developmental research at Savannah, Georgia, involves entomologists and chemists whose work has cross-commodity application. Although much of the work has a direct relation to stored tobacco, only a part of the effort has been charged to Area 11. The program is reported in Area 13.

The Federal scientific effort devoted to entomological research totals 3.9 professional man-years divided as follows: basic biology and ecology 0.8, insecticide evaluation 1.4, insecticidal control 0.5, and nonchemical control 0.3 at Richmond; insecticide evaluation 0.2 and insecticide residue analysis 0.3 at Savannah; and program leadership 0.4 at Hyattsville, Maryland.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

A. Prevention of insect infestation

1. Basic Biology and Ecology. The tobacco industry rapidly put to work the results of research on flight habits of cigarette beetles and tobacco moths. The time of day for commerical spray applications has been changed to coincide with the peak period of insect activity, and the insecticide applications are more effective. Studies of the response of tobacco insects to light led to the development of the more efficient black-light trap now widely used in tobacco warehouses. (MQ 1-7)

The recent discovery that a large percentage of cigarette beetles continue their reproductive cycle without ever emerging from tobacco hogsheads places a severe limitation on the effectiveness of space treatments as used for years in tobacco warehouses. On the basis of this information, attention is being given in the applied control projects to looking for ways to cope with this condition. Studies are also in progress to learn whether a new biological strain of the cigarette beetle may have developed that has a tendency not to emerge from the tobacco. (MQ 1-7)

Studies have been initiated to learn more about the effect of moisture content of the tobacco and relative humidity of the atmosphere on the development of the cigarette beetle and the tobacco moth. A technique has been developed to control the moisture content in small samples of tobacco by means of specific concentrations of glycerol in glass dessicators. (MQ 1-7)

2. Insecticide Evaluation. Several insecticides were applied as coatings on paper liners for 1-cubic-foot boxes of flue-cured tobacco. The boxes were placed in exposure rooms at Savannah, Georgia, where they were continuously subjected to an intense insect infestation to determine the protection that might be given to stored tobacco by the treated liners. A combination of methoxychlor, pyrethrum, and piperonyl butoxide gave complete protection for 6 months. Malathion was effective for 1 year but had some slight penetration after 2 years. Lindane and chlordane continued to give complete protection even after 2 years. Paper bands, either insecticidally treated or untreated, gave protection for 2 years in tobacco in hogsheads that had been "broken" for inspection, by preventing insect penetration into the crack in the otherwise dense mass of tobacco. (Observations on long-term studies in progress when line project BS 1-3(R) was discontinued.)

Part of the insecticide evaluation program at Savannah, Georgia, has been charged against tobacco. The entire report is included in Area 13.

3. Insecticidal Control. In a group of flue-cured tobacco storage warehouses it has been shown that a heavy early spring fumigation with HCN at 3 lbs./1000 cu. ft., followed by periodic applications of DDVP aerosol gives good protection against insect infestation. This type of "preventive program" was appreciably more effective than standard control measures in holding down damage to tobacco and in preventing the development of insect infestation. The use of the heavy initial fumigation dosage may also be at least a partial answer to the recently discovered problem of "non-emerging" cigarette beetles. This possible preventive program as suggested by results from an earlier line project (BS 1-70). The results justify further work.

(Exploratory)

4. Nonchemical Control. Preliminary studies of the effectiveness against insects of a new thermal-vacuum conditioning process for tobacco indicate that a peak temperature of about 140° F. with a steam cycle of 10 minutes is necessary to insure complete mortality of all stages of the cigarette beetle. (Exploratory)

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

Prevention of Insect Infestation.

Stored-Product Insects Branch. 1963. Oil Base for Insecticide Sprays in Tobacco Warehouses. USDA, AMS-496, 2 pp. (MQ 1)

Stored-Product Insects Branch. 1962. Stored-Tobacco Insects--Biology and Control. USDA, Agricultural Handbook No. 233, 39 pp. (Revision of former Circular No. 869.) (MQ 1)

ECONOMICS OF MARKETING
Marketing Economics Research Div., ERS

Problem. Most agricultural processing industries are experiencing rapid and drastic changes in their market organization and practices. These changes are affecting both farmer and consumers. Research is needed to keep abreast of such changes and to indicate their probable consequences. There have been substantial advances in recent years in increasing efficiency and reducing costs through adoption of new technology in producing, assembling, processing, and distributing farm products. However, for producers and marketing firms to remain competitive additional information is needed on margins, costs, economics of scale and efficiencies possible in the marketing of farm products.

USDA PROGRAM

Current work in the marketing costs, margins, and efficiency area involves analyses of the effects of selected technological changes on prices received by farmers for tobacco and on the efficiency of tobacco marketing. A major part of this work is a study of costs of redrying tobacco primarily for export. Attention is being given to the impacts on marketing costs of what appear to be excessive (and partially unused) tobacco marketing facilities, including warehouses. The total Federal effort in this area is 1.0 professional man-years. The major portion of the research work is located in Washington, D. C.

Research in the economics of product quality area involves determining the effect of technological changes now being made in the production and processing of tobacco on the farm, quality and grades in which tobacco is marketed by farmers and the impact of these changes on tobacco marketing systems. An analysis will also be made of how tobacco growers can best adapt their operations to these changes. The total Federal effort in this area is 0.5 professional man-years.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

A. Marketing Costs, Margins and Efficiency

1. Costs of Selling Looseleaf Tobacco. The efficiency in marketing and processing tobacco may be increased through selling tobacco in the looseleaf rather than the tied form. This change in marketing practices has important impacts at all stages of the marketing process, including pricing and the price-support program. As part of a study of this form of selling, a new packing frame and package was developed. The frame is rectangular in shape without a top or bottom and will hold up to 300 pounds of tobacco. A new material called knit paper was developed to contain the tobacco as it passed from the farm to the auction market and on to the processing plants.

A total of 273 experimental packages or 36,700 pounds of tobacco were sold on 5 markets during the 1962 flue-cured marketing season. Advantages of the package are: (1) A reduction of about 100 hours farm labor per acre in packing loose leaves vs. tying the leaf in "hands"; (2) leaves are packed straight-layed with butts together, which is the most convenient form for loading the processing plant conveyors; (3) burlap or cotton sheets and wooden baskets are eliminated; (4) dumping the tobacco on to baskets at the market is eliminated, thus preventing damage by tangling the leaves which caused broken mid-ribs and reduced thrashing efficiency. Tobacco buyers and farmers both liked the package and prices received for the tobacco were very satisfactory.

2. Cost and Efficiency of Looseleaf Tobacco. Growers and marketing firms continue to have a strong interest in improvements in handling tobacco at auction warehouses so as to offset rising labor and other costs and to improve in other ways the efficiency of this important marketing operation. Preliminary results of this study, still in progress, indicate that institutional rigidnesses are a serious ban to the introduction of improved methods, particularly mechanization.

3. Margins and Costs for Tobacco and Cigars. Technological and other changes in the handling, processing, and manufacturing of cigars are having pronounced effects on domestic requirements and the demand for cigar-type tobacco. The consumption of cigars after several years of moderate increases appears to have reached a plateau at an annual rate of 7 billion cigars. Cigar manufacturers have mechanized more manufacturing operations and have increased production of "short filter" cigars and the use of sheet for binders and wrappers. They have also increased their advertising programs and the number of brands, shapes, and sizes of cigars as a means of expanding consumption. The use of tobacco sheet and the introduction of small sized cigars have reduced the quantity of tobacco needed to produce a given number of cigars. Manufacturers are also experimenting with new brands, some of which require increased imports of tobacco from the Philippines, Dominican Republic, and several Latin American countries.

B. Economics of Product Quality

1. Tobacco Quality and Prices. An accurate determination of tobacco quality components and their relationship to economic value is basic to efficient marketing of tobacco and to accurate prices of tobacco to growers. The purpose of this project is to determine the interrelations among tobacco prices to growers, market conditions, and tobacco quality factors, and to suggest improvements in present grading and pricing procedures. This project is particularly appropriate now when these relationships obviously are changing rapidly as a result of changes in production methods and other factors.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

None released during the reporting period.

COOPERATIVE MARKETING
Marketing Division, FCS

Problem. Farmers continue to expand their use of cooperatives in marketing the products of their farms. In light of the rapid and complex changes taking place in technology and in market organization and practices, research is needed to help farmer cooperatives and other marketing agencies perform needed marketing services both more efficiently and more effectively. Farmer-directors, managers and others, including the public, need more information to assist in making decisions on how cooperatives can maintain and strengthen the bargaining power of farmers, increase efficiency and reduce costs of marketing, and better meet the needs of our mass distribution system for large quantities of products on a specification basis.

Farmer cooperatives are an important part of the distribution system and represent a major potential for meeting farmers' marketing problems in our modern, dynamic system. They are organized and operated to increase farmer's net income. However, cooperatives face many problems in achieving this goal. Cooperatives must find ways to consolidate volume, for example, through internal growth, merger acquisition or federation, to strengthen their market position and meet the needs of mass merchandising. Ways must be found to reduce costs by increasing efficiency through improved operating methods, better organization and management, and more use of new technologies.

USDA PROGRAM

The Department conducts a continuing long-range program of basic and applied research and technical assistance on problems of marketing farm products cooperatively. Studies are made on the organization, operation and role of farmer cooperatives in marketing. While most of the research is done directly with cooperatives, the results are generally of benefit to other marketing firms. The work is centered in Washington, D. C. Many of the studies, however, are done in cooperation with various State Experiment Stations, Extension Services, and Department of Agriculture.

The number of Federal professional man-years devoted to research in this area totals 21.2, of which 1.0 man-years are on the cooperative marketing of tobacco.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

Improving operating methods. Analysis continued on a study of the organizational and operational features of cooperative loose-leaf tobacco auctions. Preliminary results to date show that a wide variation exists among these associations in terms of members served, volume marketed, investment in facilities and efficiency in use of floor space.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

None released during the reporting period.

ECONOMIC AND STATISTICAL ANALYSIS

Economics and Statistical Analysis Div., ERS

Problem. Because of the instability of the prices he receives and rapidly changing conditions of agricultural production, the farmer stands in special need of accurate appraisals of his economic prospects if he is to plan and carry out his production and marketing activities in an efficient and profitable way. The typical farmer cannot afford to collect and analyze all the statistical and economic information necessary for sound production and marketing decisions. It has long been a goal of the Department to provide the farmer with economic facts and interpretations comparable to those available to business and industry, through a continuous flow of current outlook information; the development of longer range projections of the economic prospects for the principal agricultural commodities; and analyses of the economic implications of existing and proposed programs affecting the principal farm commodities.

Producers, processors, distributors, and consumers need better information on supplies, production and consumption of farm products, and the effect of these and other factors on the prices of these products. Similarly, Congress and the administrators of farm programs need to evaluate alternative proposals to modify existing price support and production control programs in terms of their impact on production, consumption and prices received by farmers.

USDA PROGRAM

Tobacco. This work involves 1.5 professional man-years in Washington. The outlook and situation program provides a continuing appraisal of the current and prospective economic situation of tobacco and tobacco products. Results of these analyses and findings of special studies are published quarterly in the Tobacco Situation and the Demand and Price Situation, and monthly in the Farm Index. A comprehensive analysis of the tobacco situation is presented at the Annual Outlook Conference. Situation and outlook appraisals also are presented at regional meetings, and at meetings of tobacco grower organizations and trade groups. Special analyses are prepared from time to time on the probable effect of alternative proposed programs on the price, supply, consumption and exports of tobacco. Basic statistical series are developed, improved, maintained, and published for general use in statistical and economic analysis. Recent emphasis has been placed on analyses of consumption of various kinds of tobacco in final products, and the competitive position of U.S. tobacco in world trade.

Tobacco. This work involves 0.5 professional man-year located in Washington, D. C. Current research effort relates to (1) economic factors affecting supply, price, and utilization of tobacco and tobacco products; and (2) economic effects of technological changes on supply, demand, utilization, and price of leaf tobacco. Under the first area of work, analyses which utilize both time series and cross section data are developed to measure the influence of several factors affecting consumption of cigarettes, cigars, and the other tobacco products. Analyses relating to factors affecting prices of the major kinds of leaf tobacco, and to exports and seasonality are undertaken. Under the second area of work, information and analyses are developed for evaluating the effects of consumption trends and of recent technological changes in tobacco manufacturing on supply, demand, and price of leaf tobacco. Recent changes in quantity and character of leaf demanded and utilized by manufacturers and in the traditional structure of market prices are analyzed from the standpoint of immediate and long-range effects on growers, export markets, and tobacco programs. The research program also includes modification and use of results from both areas of work in program appraisals involving effects of alternative price support levels and marketing controls.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

A. Commodity Situation and Outlook Analysis

Carryover of flue-cured, the largest-volume tobacco, at the end of the 1962-63 marketing year was a tenth above a year earlier, and carryover of burley, the second largest kind, was up moderately. The 1963 crop of flue-cured is below last year's, but the burley crop is the largest on record. Total supplies for 1963-64, carryovers plus the 1963 crops of flue-cured and burley, are indicated to be 4 and 5 percent larger, respectively, than for 1962-63.

Consumption of cigarettes and cigars in 1963 is likely to exceed 1962, but declines are indicated for smoking tobacco and snuff; chewing tobacco may hold even. An important influence on cigarette consumption in 1964 and beyond will be the nature of the report of the Surgeon General's advisory committee on smoking and health, and further developments in this field.

Exports of unmanufactured tobacco in 1963 likely will show some gain over 1962, but from a longer-term standpoint increasing competition and trade restrictions of importing countries are unfavorable factors. Unless modified in forthcoming tariff negotiations, duty rates of the European Common Market will continue to be disadvantageous to U.S. leaf; the admission of Greece and prospective admission of Turkey as associate members also adversely affect our competitive position.

Contribution was made to an interagency report on tobacco quality factors. This report reviewed all aspects of the tobacco quality problem, particularly as it affects U.S. exports, and summarized the views and recommendations of producer and buyer groups as developed in public hearings.

As investigation of certain questionable disappearance statistics was undertaken, in order to improve the basis for determining consumption trends. Considerable time was spent on a detailed analysis of tobacco exports of the United States and its principal competitors. Work was done on 5-year projections of tobacco supplies, consumption, and exports under varying assumptions. A background statement on the economic importance of tobacco, and long-term statistics on consumption of tobacco products were furnished the Surgeon General's advisory committee on smoking and health.

B. Supply, Demand and Price

Continued analysis was made of grade prices of cigarette tobaccos, and the effect of grade price changes on exports to individual markets.

Trends in utilization of tobacco as affected by recent technological changes were analyzed as to their impact on growers, and findings were included in situation and outlook reports. In 1962, use of tobacco for cigarettes is estimated at 1,218 million pounds (unstemmed processing weight)--virtually unchanged from 1961. Preliminary estimates indicate that the use of flue-cured declined a little and use of burley showed an offsetting increase. Use of imported tobacco, which showed considerable gain from 1957 to 1961, leveled off in 1962. While use of tobacco remained about the same, manufacture of cigarettes rose 1.4 percent from 1961 to 1962. The failure of tobacco usage to increase proportionately is in keeping with tendencies in recent years, and is due to increased use of sheet tobacco and stems and a further gain in filter tip cigarettes, which require less tobacco than plain tip cigarettes.

A review of present acreage controls and alternative methods of supply adjustment was prepared and presented before the National Tobacco Industry Advisory Committee. Contributions were made to analyses of various proposals and recommendations of this Committee.

Considerable time was spent in analyzing U. S. tobacco exports, with special reference to the competitive position of U. S. tobacco.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

Commodity Situation and Outlook Analysis

Conover, A. G. and Sackrin, S. M. Tobacco Situation. Published quarterly. ERS, USDA, Washington, D. C.

Conover, A. G. and Sackrin, S. M. Tobacco Situation. Published quarterly. ERS, USDA, Washington, D. C.

Sackrin, S. M. November 1962. Cigarette output in 1962 forecast at new record high. Agricultural Situation.

Conover, A. G. December 1962. The tobacco outlook for 1963. Agricultural Situation.

Conover, A. G. July 1963. How much have tobacco and cigarette prices gone up. Agricultural Situation.

X Tobacco Quality Problems. February 1963. A report prepared by an inter-agency committee, U. S. Department of Agriculture, of which Arthur G. Conover was a member. Unnumbered publication.